Evening Star

How a Steam Locomotive Works

These notes describe the operation of a steam locomotive with a particular reference to the screen display and controls of Evening Star. Understanding how a steam locomotive works will help you to master the controls more quickly.

The driving force of the locomotive comes from the cylinders where a piston is pushed back and forth by the steam pressure raised in the boiler. Hot gasses from the firebox are drawn through the boiler by a system of tubes, which heat the water to boiling point, converting it into steam. The hot gasses drawn through the boiler then enter the smokebox and escape through the chimney. The performance of the locomotive depends upon the pressure in the boiler, which can be controlled by manipulating the fire.

WATER GAUGES

These are two vertical tubes in the centre of the cab. They are very important as they give a visual indication of the level of water in the boiler. The bottom of the gauge is one inch above the firebox top, which must be kept covered at all times otherwise the fire will heat the firebox top beyond limits causing special plugs (called fusible plugs) to melt allowing steam into the firebox. This action cools the fire and alerts the train crew.

If too much water is carried in the boiler and the gauge reaches the top, water instead of steam will enter the cylinders causing permanent damage.

Ideally you should attempt to maintain a water level in the top half of the gauge. Should a failure occur, the run will be terminated with the consequential loss of marks.

STEAM PRESSURE GAUGE

A round dial with a needle pointer, situated in the centre of the cab, graduated from minimum on the left to maximum (200 psi) on the right. The more steam pressure maintained the higher the potential power of the locomotive. However too much pressure will lift the safety valves and release steam thereby reducing pressure to below maximum (shown by two jets of steam issuing from the boiler top). This represents a waste of coal and water and should be avoided to achieve maximum efficiency.

WHISTLE

The whistle is part of the safety equipment and must always be used before starting away, entering tunnels or approaching sections where permanent way gangs (railway maintenance teams) are working. To conserve steam the whistle should not be used indiscriminately.

As a guide to correct whistle usage, when the computer is controlling the whistle it is blown at the earliest time in each of the circumstances detailed above.

REGULATOR

A lever situated on the top left of the cab which controls the flow of steam to the cylinders. It has five positions, closed on the right, progressing to fully open on the left. Opening the regulator applies power to the wheels and it must be adjusted when running to suit requirements. Always close the regulator when braking. Open the regulator cautiously when starting away as too much power will cause the wheels to slip (especially in adverse weather conditions). Wheel slip will be apparent from the increase in the speed of the steam exhaust.

CUT OFF

A wheel control on the bottom left (marked C) which controls the time during each cylinder cycle that steam is allowed into the cylinder. It has five positions, 0% (straight up), 20%, 35%, 55% and 75% (straight down). For example when the cut off is set to 20%, steam is allowed to enter for just 20% of the cycle. This has the effect that the expansive properties of steam are used more efficiently, by reducing the steam usage significantly for only a small loss of power. You will need to use this control to obtain high efficiency. When starting away it is normal practice to use 75% cut off.

VACUUM BRAKE

A wheel control situated between the regulator and the cut off (marked V) which has five positions; off (straight up), light braking, medium braking, heavy braking and emergency braking (straight down). The brakes act upon all the carriages and are held off by maintaining a vacuum in a pipe connecting the carriages, braking being achieved by progressive release of the vacuum via the vacuum brake control.

In the event that the communication cord of the train is pulled, emergency braking is automatically applied and will be released as appropriate. Emergency braking must not be used by the driver except in extreme circumstances, as a poor safety rating will result. Avoid using harsh braking to bring the train to a halt at a station for the comfort of your passengers.

BLOWER

A wheel control situated centre right of the cab (marked B) which is off when pointing straight

up. It is essential that at all times gasflow is maintained drawing the gasses from the firebox out through the chimney ensuring that no flames or gasses are allowed to escape into the cab via the firehole doors. Normally this gasflow is supplied by the exhaust of used steam up the chimney when the regulator is open. This gasflow will be interrupted by closing the regulator or by the confines of a tunnel. In these circumstances normal gasflow must be maintained by opening the blower which sends a jet of live steam up the chimney. Failure to use the blower when necessary is dangerous and can lead to an "explosive blowback" into the cab. Use of the blower should be limited to only when necessary due to its cost in the loss of steam.

INJECTORS

A wheel situated top right of the cab (marked I), which controls the device by which water from the tender is forced into the boiler. It has five positions, off (straight up), progressing to full on (straight down). This is the means by which the level of water in the boiler is maintained.

DAMPERS

A wheel situated on the bottom right of the cab (marked D) which controls the amount of air provided through the base of the fire (called primary air). It has five positions, closed (straight up) progressing to fully open (straight down). By control of the amount of primary air it is possible to vary the temperature of the fire and thereby the amount of water evaporated into steam. To achieve a hot fire a large amount of primary air is required for combustion. Conversely for a cool fire only a small amount of primary air is required. To help you judge the temperature of your fire a thermometer style temperature gauge is presented in the cab centre. The indication of correct combustion is the colour of your smoke such that black smoke would indicate insufficient air for the temperature of the fire, grey smoke indicates correct air and lighter shades indicate too much air. If too little air is supplied coal combustion will not provide the maximum heat value. If too much air is supplied, heat will be wasted in heating the excess air. To be efficient you must aim to maintain the correct air supply as far as possible. (Whilst manipulating the fire temperature correct combustion is unlikely). The rate at which coal is consumed increases with the temperature of the fire.

FIREHOLE DOORS

A pair of steel doors used to confine the fire and to control the flow of air over the fire (secondary air). To achieve optimum temperatures of the fire, the level of coal must be maintained in the middle third of the firebox. Coal levels outside these parameters cannot achieve maximum temperatures. You must fully open the firedoors

whilst coal is being added (indicated by a shovel at the top right hand corner of the display). Failure to do so will waste coal. In all but the highest level of control the computer will do this for you. For perfect combustion a small amount of secondary air may be required.

The firedoors can also be used to assist in the manipulation of fire temperature. For example to raise the temperature of the fire "quickly" keep the firedoors shut, and to lower the temperature "quickly" open wide.

GRADIENTS

Railway lines are not level and steam railway locomotives are affected by the gradient of the track. The gradient is indicated in the same manner as road gradients, e.g. 1 in 100. This would indicate a slope up or down of one foot for every 100 feet travelled. A cross section of the gradients of the line together with the positions of the stations and tunnels is shown in the gradient profile included. The exact gradient of the track at any particular time may be displayed in the signalling area.

Vacuum brakes must be used to ensure that the train is never allowed to run backwards on an up gradient.